Ontario Geological Survey
Aggregate Resources Inventory
Paper 83

Aggregate Resources Inventory of Glenelg Township Grey County Southern Ontario

By Staff of the Engineering and Terrain Geology Section
Ontario Geological Survey

1984

Ontario
Ministry of Natural Resources

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Minister

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ISSN 0708-2061
ISBN 0-7743-6471-8

This report was prepared by: Staff of the Aggregate Assessment Office, Engineering and Terrain Geology Section of the Ontario Geological Survey, Ontario Ministry of Natural Resources, 77 Grenville Street, Toronto, M5S 1B3, Telephone (416) 965-1182.

Project Supervisor: Dale W. Scott
Text Prepared by: D. Tennant
Compilation and Drafting by: Staff of the Aggregate Assessment Office

The Mineral Resources Staff of Owen Sound District and Southwestern Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

Parts of this publication may be quoted if credit is given to the Ontario Ministry of Natural Resources, Ontario Geological Survey. It is recommended that reference to this report be made in the following form:

Ontario Geological Survey
1984: Aggregate Resources Inventory of Glenelg Township, Grey County; Ontario Geological Survey, Aggregate Resources Inventory Paper 83, 49 p., 7 tables, 3 maps, scale 1:50 000.

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

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CONTENTS

Page

Abstract v
Introduction 1
Part I - Inventory Methods 2
Field and Office Methods 2
Resource Tonnage Calculation Techniques 2
Sand and Gravel Resources 2
Bedrock Resources 3
Units and Definitions 3
Part II - Data Presentation and Interpretation 4
Map 1 Distribution of Sand and Gravel Deposits 4
Deposit Symbol 4
Texture Symbol 4
Map 2 Selected Sand and Gravel Resource Areas 5
Site Specific Criteria 5
Deposit Size 5
Aggregate Quality 5
Location and Setting 6
Regional Considerations 7
Map 3 Bedrock Resources 7
Selection Criteria 7
Selected Resource Areas 8
Part III - Assessment of Aggregate Resources in Glenelg Township 9
Location and Population 9
Physiography and Surficial Geology 9
Extractive Activity 10
Selected Sand and Gravel Resource Areas 10
Selected Sand and Gravel Resource Area 1 11
Selected Sand and Gravel Resource Area 2 11
Selected Sand and Gravel Resource Area 3 12
Selected Sand and Gravel Resource Area 4 12
Selected Sand and Gravel Resource Area 5 13
Sand and Gravel Resource Areas of Secondary Significance 13
Bedrock Geology 14
Summary 15
References 38
Appendix A - Suggested Additional Reading 40
Appendix B - Glossary 41
Appendix C - Geology of Sand and Gravel Deposits 44
Appendix D - Geology of Bedrock Deposits 46

TABLES

1 - Total Sand and Gravel Resources, Glenelg Township 16
2 - Sand and Gravel Pits, Glenelg Township 18
3 - Selected Sand and Gravel Resource Areas, Glenelg Township 25
4 - Total Identified Bedrock Resources, Glenelg Township 27
5 - Quarries, Glenelg Township 28
6 - Selected Bedrock Resource Areas, Glenelg Township 29
7 - Summary of Test Hole Data, Glenelg Township 30

FIGURES

1 - Key Map Showing the Location of Glenelg Township v
2a - Aggregate Grading Curves, Glenelg Township 34
2b - Aggregate Grading Curves, Glenelg Township 35
3a - Aggregate Grading Curves, Glenelg Township 36
3b - Aggregate Grading Curves, Glenelg Township 37
4 - Bedrock Geology of Southern Ontario 46

MAPS
(back pocket)

1 - Distribution of Sand and Gravel Deposits, Glenelg Township, Scale 1:50 000.
2 - Selected Sand and Gravel Resource Areas, Glenelg Township, Scale 1:50 000.
3 - Bedrock Resources, Glenelg Township, Scale 1:50 000.

ABSTRACT

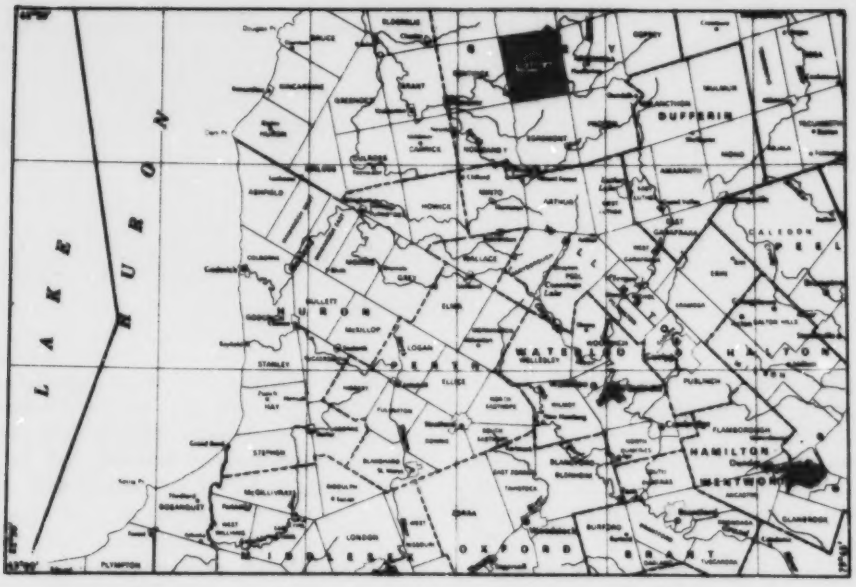

Figure 1 - Key Map Showing the Location of Glenelg Township, Scale 1:1 800 000.

This report includes both an inventory and analysis of sand and gravel as well as bedrock resources in Glenelg Township. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under The Pits and Quarries Control Act, 1971.

The sand and gravel deposits in Glenelg Township are an important regional source of road-building and construction aggregate. Five areas containing good-quality sand and gravel have been selected for possible resource protection at the primary level. All of the selected areas are part of a large physiographic unit known as the Artemesia Gravel. The Primary Resource Areas cover 11,300 acres (4550 ha), exclusive of licenced properties. Approximately 8300 acres (3350 ha) are considered to be available for extraction. The available areas contain possible resources of 430 million tons (390 million tonnes) of sand and gravel. The available portions of the selected areas represent 25 percent of the total area of sand and gravel deposits in the township and 26 percent of the total resource tonnage.

In addition, several deposits have been selected as Sand and Gravel Resource Areas of Secondary Significance. Although these secondary deposits are not considered the "best" resources, they should be considered part of the township's total aggregate supply.

The underlying bedrock unit in Glenelg Township is the Guelph Formation. Although the Guelph Formation has high chemical purity, it is unsuitable for load-bearing aggregate. In addition, much of the bedrock is covered by more than 50 feet (15 m) of drift. For these reasons, no areas have been selected for resource protection.

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

AGGREGATE RESOURCES INVENTORY OF GLENELG TOWNSHIP[1]

BY
STAFF OF THE ENGINEERING
AND TERRAIN GEOLOGY SECTION

INTRODUCTION

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1979, the total tonnage of mineral aggregates extracted was 144 million tons (131 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1980).

Although mineral aggregate deposits are plentiful in southern Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the reports. As new information becomes available, revisions may be necessary.

[1] Manuscript accepted for publication by Chief, Engineering and Terrain Geology Section, July 19, 1984.
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PART I - INVENTORY METHODS

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References). Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing and hand-augering techniques were used to assess subsurface materials. Airphotos at various scales were used to determine the continuity of deposits, especially in areas of limited subsurface information.

Deposits with potential for further extractive development or those where existing data are scarce, were studied in greater detail. Representative layers in these deposits were sampled in 25- to 100-pound (11 to 45 kg) units either from existing pit faces or from test pits dug by backhoe. The samples were analysed for grain size distribution and in some cases for petrographic assemblage. Analyses were performed by the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications. In areas of limited subsurface exposure, drilling using a powered hollow stem auger was undertaken. The stratigraphic sections in these test holes are described in drill logs included in the report as Table 7. In some cases samples taken during the course of the drilling were analysed to determine grain size distribution. The symbols for and locations of test hole sites are noted on Map 1.

In the office, the pit and field sample data were supplemented by information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under The Pits and Quarries Control Act, 1971 were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates, or to indicate the presence of buried granular material. These records were used only in conjunction with other evidence. Soil reports published by the Ontario Ministry of Agriculture and Food were also consulted in order to supply additional information in areas with limited data. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a township base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data

such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) in extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 represent only those parts of the deposit lying outside licenced areas (Column 2). Two successive subtractions are made from the unlicenced area. Column 3 accounts for the number of acres unavailable due to the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas lying outside of licenced properties that have previously been extracted (e.g. wayside pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of favorable bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps and from the interpretation of water well records. The measured extent of such areas is then multiplied by the estimated workable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of a workable thickness of 60 feet (18 m) is used. Volume estimates are then multiplied by 3600 (the estimated weight in tons of a one-foot (0.3 m) thick section of dolostone, one acre (0.4 ha) in extent, assuming a bulk density of 165 pounds per cubic foot (2649 kg per cubic metre)).

Resources of sandstone are calculated using a bulk density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) or approximately 3200 tons per acre (7173 tonnes per hectare). Shale resources are calculated on the basis of a bulk density estimate of 150 pounds per cubic foot (2408 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel as well as bedrock-derived aggregates are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p. 7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

PART II - DATA PRESENTATION AND INTERPRETATION

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources", shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

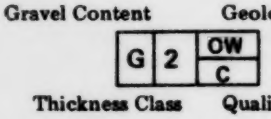
Map 1 is derived directly from the existing surficial geology maps of the area or from airphoto and field interpretation where surficial mapping is incomplete. It shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

The present level of extractive activity in the study area is indicated as follows. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are also identified and numbered on Map 1 and described in Table 2.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for a given deposit. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the aggregate probably contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identify the main quality limitations that may be present in the deposit, as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The data from which these symbols are derived has been plotted on grain size distribution graphs. The relative amounts of gravel, sand, silt, and clay in the sampled material are shown graphically by the sub-

division of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. These areas are identified on Map 2 by different shading patterns. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by a dark shading on Map 2.

Selected Sand and Gravel Resource Areas of primary significance are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by a light shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resource areas in a municipality, they may contain large quantities of sand and gravel and should be considered an integral component of the aggregate supply of the municipality.

Areas of tertiary significance are indicated on the map by a dashed line but have no shading. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the municipality is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

DEPOSIT SIZE

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6m) and containing more than 35 percent crushable gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

AGGREGATE QUALITY

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content (G or S) indi-

cates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (or high silt and clay content) may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphaltic aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock formations determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high-quality uses such as concrete or structures. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations. The Engineering Materials Office of the Ontario Ministry of Transportation and Communications has recently compiled a detailed assessment of aggregate suitability for selected areas in southern Ontario. This material has been consulted extensively in preparation of the inventory reports.

Analyses of unprocessed samples obtained from test holes and pits have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products — Granular Base Course A,B, and C; and Hot-Laid Asphaltic Sand Nos. 1, 2, 3, 4, 5, 6 and 8. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

LOCATION AND SETTING

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of those natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, power lines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report but

readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain at roughly the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, bedrock topography, drift thickness maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources), and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of the areas of thin drift are shown by three shades. The darkest shade indicates areas where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas constitute potential resource areas of primary significance because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these also represent potential resource areas. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive sand and gravel deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the municipality. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, and licenced acreage of the quarry and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under authority of a permit) are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected well which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and

Communications. The main characteristics and uses of the bedrock formations found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations of sufficient thickness to support quarry operations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource is usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approach. First, quality and quantity variations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

PART III - ASSESSMENT OF AGGREGATE RESOURCES IN GLENELG TOWNSHIP

LOCATION AND POPULATION

Glenelg Township occupies approximately 69,508 acres (28 130 ha) in the southern portion of Grey County, southern Ontario. The township is shown on the Durham (41 A/2) and the Markdale (41 A/7) map sheets of the National Topographic System, at a scale of 1:50 000.

In 1982 the township's population was 1488; the population has grown relatively steadily since 1972, showing an increase of 16 percent between 1972 and 1982 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974). The township supports a mixture of farming and non-farming activities.

The Town of Durham is the major urban centre adjacent to Glenelg Township and serves as a commercial, industrial and institutional centre on a regional level. It is located on King's Highway 6 in the southwestern part of the township. Durham's population in 1982 was 2430, a slight decrease since 1972 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974). There are no indications that the growth rate will accelerate rapidly in the foreseeable future (Durham Planning Board 1979). The current economy of the town is manufacturing and commercial activities including the forest products industry and aggregate extraction and processing.

The Village of Markdale is located on the northeastern boundary of Glenelg Township. The village's 1982 population was 1260 (Ontario Ministry of Municipal Affairs and Housing 1983). Along with several smaller centres such as Priceville, Dornoch and Ebordale, Markdale provides local services to the surrounding rural population.

Access to the township is provided by King's Highway 6, which forms its western boundary, and King's Highway 4 which runs east-west through Durham and Priceville. Various county and township roads provide connecting links within the township.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

Approximately 23 000 years ago, during the Late Wisconsinan Substage of the Pleistocene Epoch (informally known as the "Great Ice Age"), lobes or submasses of the Laurentide continental ice sheet advanced out of the basins of the Great Lakes and joined together to cover southern Ontario. The lateral extent of the ice lobes and the positions of their margins underwent numerous fluctuations until approximately 10 000 years ago when the ice finally melted back and completely disappeared. The physiography and distribution of surficial materials in Glenelg Township, and specifically the sand and gravel deposits shown on Map 1 of this report, are the result of the activities of the Georgian Bay ice lobe during this time period.

Parts of three major physiographic regions are found in Glenelg Township: the Dundalk Till Plain (Chapman and Putnam 1966); the Horseshoe Moraines (Chapman and Putnam 1966; Feenstra 1975 and Sharpe 1975); and the Teeswater Drumlin Field (Chapman and Putnam 1966; Sharpe, in prep.). The Dundalk Till Plain occurs in eastern and southeastern Glenelg, and the surface till in this area, deposited at the base of the glacier, is the Elma Till. The Elma Till is a stony, sandy silt till. It is not suitable for use as aggregate because it contains excessive amounts of fine material.

The Singhampton Moraine, and the outwash deposits associated with both the Singhampton and Gibraltar Moraines, represent a portion of the Horseshoe Moraines system. The Singhampton Moraine extends diagonally from southeast of Durham to northwest of Markdale, and covers most of central and eastern Glenelg Township. The moraine was formed by continued sediment accumulation at the margin of the Georgian Bay ice lobe as it melted back through the area, toward the northwest. The accumulated sediment is primarily the product of a glaciofluvial environment and can be divided into two major types: stratified ice-contact sand and gravel sediments; and large, braided channel outwash sand and gravel deposits (Sharpe, in prep.).

After forming the Singhampton Moraine the

Georgian Bay lobe melted back to a position north and west of Glenelg Township, where it created the Gibraltar Moraine. As with the Singhampton Moraine, the formation of the Gibraltar Moraine was accompanied by the deposition of large quantities of outwash sediment, part of which is located in Glenelg Township, west of the Singhampton Moraine.

The two large outwash deposit complexes which front the Singhampton and Gibraltar Moraines are called the Artemesia Gravel (Logan 1863; Sharpe, in prep.). In combination with the ice-contact stratified drift of the Singhampton Moraine, the outwash deposits are the most significant natural aggregate sources in Glenelg Township. The material they contain is suitable for a wide range of aggregate products, including, in some places, high-specification asphaltic aggregate.

The Teeswater Drumlin Field occurs west of the Singhampton Moraine and is a drumlinized ground moraine which consists of Elma Till. The drumlins, formed during the advance of the Georgian Bay ice lobe, are often covered by outwash and ice-contact sediment deposited during the subsequent melting of the ice lobe. The drumlins themselves are not considered aggregate sources because of excess fine-grained material, however, the ice-contact or outwash deposits superimposed on them are potential sources of aggregate.

Postglacial erosional and depositional processes have been of minor importance in modifying the physiography of Glenelg Township. Postglacial deposits of marl occur at Tobermory Lake, Townsend Lake and Bells Lake. Only the Bells Lake deposit is of fairly good size and quality. Marl was used at the turn of the century for the manufacture of portland cement. Today the most likely market for this material is in the area of industrial fillers (Feenstra, in prep.).

EXTRACTIVE ACTIVITY

In 1975, Glenelg Township was designated under The Pits and Quarries Control Act, 1971. Prior to that time, numerous small pits had been active in the township. Ninety-five pits (for which information is available) have been identified in this report. Most of these pits are now inactive (abandoned). The Ontario Ministry of Transportation and Communications (M.T.C.) has rated forty-five of these pits. Thirty-one pits are considered to be moderate- to high-quality aggregate sources, capable of producing crushed aggregate for Granular Base Course (G.B.C.) A, and in some cases, for hot-laid asphaltic products.

In Glenelg Township there are currently seven pits licenced for extraction under The Pits and Quarries Control Act, 1971. The pits are located in the Artemesia Gravel and in the ice-contact stratified drift deposits of the Singhampton Moraine. The total area of these licenced properties is 1398.4 acres (565.9 ha). From 1975 to 1981 the average annual licenced production from Glenelg Township was 134,136 tons (121 688 tonnes). Average annual wayside pit production for the same period of time was 45,730 tons (41 486 tonnes). Wayside pits are temporary pits opened and used by a public road authority solely for the purpose of a particular project or contract of road construction.

SELECTED SAND AND GRAVEL RESOURCE AREAS

Glenelg Township contains 33,500 acres (13 600 ha) of sand and gravel deposits. The total estimated tonnage in these deposits is 1620 million tons (1470 million tonnes). The best quality aggregate is found in the central and southern parts of the township in the Artemesia Gravel. The five areas selected for possible resource protection at the primary level in Glenelg Township are located in this area.

The Primary Resource Areas cover 11,300 acres (4550 ha), exclusive of licenced properties. Approximately 8300 acres (3350 ha) are considered to be available for extraction, containing a total tonnage of 430 million tons (390 million tonnes). The available portions of the selected areas represent 25 percent of the total area of sand and gravel deposits in Glenelg, and 26 percent of the original tonnage.

Lithologically, the outwash contains hard, rounded cobbles of dolostone (85 percent Guelph and Amabel Formations) and limited amounts of limestone (10 percent) and Precambrian material (5 percent) (Sharpe, in prep.). Many of the selected deposits contain sandy areas in addition to areas of good-quality crushable gravel. The presence of oversize material in the deposits is relatively common. Oversize material must either be removed, or crushed in order to be incorporated into an aggregate

product. The selected areas contain negligible or very low amounts of deleterious material.

Several deposits have been designated for secondary resource protection. These secondary areas serve as important alternate extraction sites and should be considered as part of the total aggregate supply.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 consists of three separate outwash gravel deposits located in the southwestern part of Glenelg Township. Resource Areas 1a and 1b extend into neighbouring Bentinck Township and join together to form one large deposit. Selected Resource Area 1 occupies approximately 5600 acres (2270 ha), exclusive of licenced properties. The deposit areas are individually listed in Table 3.

Licenced pits 2, 3, 4, and 5 are wholly or partially located within Resource Area 1. Licenced pits 4 and 5 have been active for several years. Faces in pit 4 range from 15 to 25 feet (5 to 8 m), and contain poorly sorted, stratified sand and gravel with occasional silt seams. Gravel percentage is variable and ranges from 30 to 70 percent. The pit has a moderate-high rating according to the standards established by M.T.C., and can supply aggregate for select subgrade, G.B.C. A, B and C, 16 mm Crushed Stone, Hot-Laid (H.L.) Nos. 4 and 8 stone, and hot-laid sand products (Deike 1978b). Because of the grain size variability in the pit, oversize material must be removed or crushed to meet G.B.C. B specifications, and blending is required to produce satisfactory hot-laid sand products.

At the time of field investigation, the face of pit 5 exposed 10 to 20 feet (3 to 6 m) of horizontally bedded, rounded to well rounded, fine to coarse outwash gravel, interstratified with fine to coarse sand. The gravel content ranged from 40 to 60 percent. The area directly west of the pit has been extensively worked in the past but is not currently under licence. Face heights in this pit are 10 to 25 feet (3 to 8 m). Although most faces were sloughed, one relatively clean face showed up to 90 percent fine aggregate. Sandy lenses do occur in this part of the deposit, and are more prominent in the marginal areas. The sand and gravel rests primarily on a dense clay silt till, although in the northwestern section of the pit property it may rest on bedrock (Sado 1976b; Sharpe, in prep.).

The sand and gravel in pit 5 can be used to produce a full range of fine and coarse aggregate products from select subgrade to hot-laid asphaltic aggregates and concrete sand. There is a permanent hot-mix plant on site which produces H.L. 2, 3, 4 and 6 (sand and stone). Data obtained from M.T.C. indicate that the aggregate grading and percentage crushable material in the pit can sometimes be a problem in terms of producing hot-laid coarse aggregate, and that blending is required to achieve satisfactory hot-laid sand products.

In addition to the licenced pits, Selected Area 1 also contains eighteen abandoned pits (pit nos. 47, 52 to 55, 59, 60, 62, 72, 73, 76 to 80, and 88 to 90). Face heights in these pits vary from 5 to 40 feet (1.5 to 12 m) and expose 30 to 65 percent gravel. Based on visual estimates, most of the pits are potential sources of crushable material (Sado 1976b). The pits have been rated as moderate to moderate-high aggregate sources, according to M.T.C. specifications. This means that the pits can produce G.B.C. A and in some cases H.L. 4 stone.

After deletions for cultural setbacks and previous extraction, Selected Resource Area 1 has approximately 3950 acres (1600 ha) currently available for aggregate extraction. Based on an average thickness of 25 feet (8 m) of useable material, the deposits contain an estimated 222 million tons (201 million tonnes) of sand and gravel.

The deposits are easily accessible by King's Highways 4 and 6 and various county and township roads. A Canadian Pacific Railway line runs through Area 1b. This line has been used in the past to transport aggregate from the Durham area (Hewitt and Karrow 1963).

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 is an outwash gravel deposit located in the northwestern part of Glenelg Township, in the Gibraltar member of the Artemesia Gravel. The deposit covers 580 acres (235 ha).

Although Area 2 contains no licenced pits, there are four abandoned pits within the deposit (pit nos. 38 to 41). The faces expose 45 to 60

percent gravel, 30 to 70 percent of which is greater than 1 inch (25 mm), and 7 to 20 percent of which is greater than 4 inches (100 mm). The oversize material is generally no greater than 2 to 3 feet (0.6 to 1 m) in diameter.

Pit 39 has been rated as a moderate to high prospect, according to the criteria set out by M.T.C. This rating indicates that the material in the pit can be used to produce select subgrade, G.B.C. A, B and C, 16 mm Crushed Stone, and H.L. 4 and 8 stone. Oversize material must be removed or crushed for G.B.C. B. Although the other pits have not been rated by M.T.C., visual estimates of the percentage of various sizes of gravel within them indicate that they are potential crushable sources (Sado 1976b). Based on the known geological characteristics of Selected Resource Area 2, it is expected to be similar to Resource Area 1, and may support similar types of operations.

Approximately 440 acres (178 ha) of Selected Sand and Gravel Resource Area 2 are considered to be available for aggregate extraction. Based on an average of 20 feet (6 m) of suitable material, the deposit contains an estimated 22 million tons (20 million tonnes) of aggregate. The deposit is accessible by various township roads.

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Selected Sand and Gravel Resource Area 3 is composed of seven outwash gravel deposits located north and south of the Rocky Saugeen River, in central Glenelg. As a group, the deposits occupy approximately 1680 acres (680 ha), exclusive of the licenced property. These deposits were formed by meltwater streams which flowed in a southerly direction through the Teeswater Drumlin Field and the Singhampton Moraine (Feenstra, in prep.).

Licenced pit 1 is located in Area 3a. The pit faces expose material composed of 20 to 45 percent gravel and are 20 to 25 feet (6 to 8 m) in height. The M.T.C. has rated the pit as being a moderate prospect, which means it can produce G.B.C. A, as well as select subgrade and pit-run products. Abandoned pits 21, 22, 23, 45 and 49 are also located in Resource Area 3. The face heights range from 5 to 25 feet (1.5 to 8 m), and expose 30 to 50 percent gravel, with 10 to 50 percent being greater than 1 inch (25 mm), and 2 to 10 percent being greater than 4 inches (100 mm). Pits 21, 23 and 49 are possible crushable sources.

Reconnaissance drilling was carried out in Area 3b. Test hole GL-TH-4 showed a thin veneer of topsoil over coarse gravel with medium sand and some silt to 10 feet (3 m). The test hole was terminated at 10 feet (3 m) because the machine was unable to penetrate further, because of coarse material. Split spoon sampling was not possible because of the size of material encountered so a grab sample was taken off the augers. Results of a grain size analysis of the sample showed that it was 87 percent gravel, 9 percent sand and 4 percent silt (Figure 3a). More specifically, the sample contained material suitable for the production of G.B.C. A, B and C, and 16 mm Crushed Stone B. Because of the coarse nature and the amount of the gravel fraction, crushing would be required to produce these products. The material was not suitable for use in the production of asphalt sand (Figure 3b). Petrographic analysis of the coarse fraction resulted in a corrected granular and 16 mm crushed petrographic number (P.N.) of 104.5, and a hot-mix, mulch, and concrete petrographic number of 118.7. These numbers are well within the petrographic number requirements for most aggregate products.

Water wells located in Selected Resource Area 3 indicate 15 to 60 feet (5 to 18 m) of sand and gravel in the various deposits. In places the deposits rest on bedrock, particularly in the area north of Traverston.

Selected Resource Area 3 contains 1360 acres (550 ha) of sand and gravel. Assuming an average depth of 20 to 25 feet (6 to 8 m) of suitable material, an estimated 81 million tons (74 million tonnes) of aggregate is available. The deposit is easily accessible by various township and county roads.

SELECTED SAND AND GRAVEL RESOURCE AREA 4

Selected Sand and Gravel Resource Area 4 is a group of seven outwash gravel deposits located in the central part of Glenelg. The deposits run primarily north-south between the Rocky Saugeen and the Saugeen Rivers. They are considered to be included in the Gibraltar member of the Artemesia Gravel.

There is one abandoned pit (pit no. 61) located in Area 4a. The pit contains 50 percent

gravel, 65 percent of which is greater than 1 inch (25 mm), and 20 percent of which is greater than 4 inches (100 mm). The maximum observed oversized clast was 2 feet (0.6 m) in diameter. These visual estimates indicate that the pit is a possible source of crushable material, however, testing would be required to determine what products the pit could produce. The pit face height is 15 feet (5 m).

Water wells in Selected Resource Area 4 show 21 feet (6 m) to 58 feet (18 m) of sand and gravel. No other data are available for the deposits, but the areas have been selected on the basis of their geological characteristics which can be inferred from their mode of deposition, and their relationship with surrounding deposits.

The 700 acres (285 ha) considered to be available for extraction are expected to contain material similar to that contained in Resource Area 1. Based on an average deposit depth of 15 feet (5 m), Area 4 contains an estimated 26 million tons (24 million tonnes) of aggregate. The deposits are readily accessible by various township roads.

SELECTED SAND AND GRAVEL RESOURCE AREA 5

Three pitted outwash gravel deposits located in the vicinity of Priceville form Selected Resource Area 5. The deposits are included in the Singhampton member of the Artemesia Gravel and contain sheets of sub-horizontally stratified coarse and oversize gravel (Sharpe, in prep.).

Licenced pit 7 includes part of Area 5a. At this location, the deposit contains 45 to 70 percent gravel. Abandoned pits 58 and 81 contain 30 to 35 percent gravel and have face heights of 10 feet (3 m). There are no pits in Areas 5b and 5c. Water wells located in the deposits show 6 to 56 feet (2 to 17 m) of sand and gravel, with some clay. Terrace heights in the outwash along the Saugeen River indicate a minimum thickness of 15 feet (5 m) (Sharpe, in prep.).

Selected Sand and Gravel Resource Area 5 occupies 2550 acres (1030 ha), exclusive of licenced properties. Approximately 1840 acres (740 ha) are considered to be available for extraction. Assuming an average deposit thickness of 15 to 20 feet (5 to 6 m), Area 5 contains 79 million tons (72 million tonnes) of aggregate. Testing is required to identify specific areas suitable for extractive development.

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

Several deposits in the southeast half of Glenelg Township have been selected as secondary resource areas. The deposits consist of large areas of ice-contact stratified drift and two smaller outwash deposits. All of the secondary deposits are associated with the Singhampton Moraine. Although the secondary areas do not contain the best quality aggregate, they provide important alternate sources, and should be considered part of the township's aggregate supply.

The largest secondary deposit lies along the eastern township boundary and extends into Artemesia Township where, in combination with the extension of Selected Resource Area 5a, it has been described as a gravel outwash deposit (Ontario Geological Survey 1981; Sado 1976a). Because of the glaciofluvial nature of the ice-contact material, it is difficult to distinguish it from outwash when good exposures are not available. More recent investigations of the Quaternary geology in the area (Feenstra, in prep.; Sharpe, in prep.) delineate separate deposits of ice-contact and outwash gravel as shown on Map 1 of this report. In 1981, a wayside pit (pit no. 51) was opened within the ice-contact deposit, in the vicinity of Irish Lake. The pit has a face height of 10 to 15 feet (3 to 5 m) and contained 30 to 50 percent gravel. The pit face exposes poorly sorted, horizontally stratified, faulted and contorted sand and gravel. Water well records show 22 to 117 feet (7 to 36 m) of sand, gravel, stones and boulders, with occasional clay. Further information is not available for the deposit, however it may contain moderate to large amounts of relatively good-quality aggregate. Testing is required to establish the quality and extent of specific areas for aggregate extraction.

Another ice-contact gravel deposit located south and west of the Saugeen River contains abandoned pits 63, 65, 66 and 67. The face heights in the pits range from 5 to 15 feet (1.5 to 5 m) and contain 10 to 60 percent gravel. In pits 63, 65 and 66, 20 to 60 percent of the gravel fraction is estimated to be larger than 1 inch (25 mm) in size, and 1 to 20 percent larger than 4 inches (100 mm) in size (Deike 1978b;

Sado 1976b). Pit 63 has been evaluated by M.T.C. and was found to contain material suitable for use in G.B.C. A, B and C, 16 mm Crushed Stone A and B, H.L. 4 and 8 stone, and with blending, hot-laid sand products. Oversize material must be removed or crushed in the production of G.B.C. B.

A third ice-contact gravel deposit is much smaller and is located just north of the two previously described deposits. Drilling was carried out in the deposit and test hole GL-TH-5 showed 31.5 feet (9.6 m) of coarse to fine sand and gravel with a trace of silt and clay. Upon analysis, a grab sample taken from 10.5 to 11.5 feet (3.2 to 3.5 m) depth was found to contain 80 percent coarse and fine gravel, 16 percent sand and 4 percent fines (Figure 3a). With sceening and crushing, the material in the sample would be suitable for use in the production of G.B.C. A, B and C. It would not be suitable for use in asphaltic sand because of the excessive fines content. Petrographic analysis of the sample yielded a corrected granular and 16 mm crushed P.N. of 100, and a hot-mix, mulch and concrete P.N. of 100.6, which indicates the material is suitable for most aggregate products. One water well in the deposit indicates 123 feet (38 m) of gravel and stones.

Another secondary resource area is located along the southern boundary of the township. The area is part of a very large ice-contact deposit which traverses Artemesia, Glenelg, Egremont, and Normanby Townships. The deposit, which forms a part of the Singhampton Moraine, contains thirteen abandoned pits (pit nos. 68-71, 82-86, 91, 92, 94 and 95) and two licenced pits (pit nos. 6 and 7).

Such a large ice-contact deposit is extremely variable. The pit face heights vary from 5 to 30 feet (1.5 to 9 m) and contain 10 to 60 percent gravel. Pits 68, 84, and 92 have been evaluated by M.T.C. and their findings illustrate the range of material that may be encountered in the deposit. Pit 68 contains material suitable for the production of select subgrade, G.B.C. A, 16 mm Crushed Stone and H.L. 4 and 8 stone. The material is too coarse for use in G.B.C. B. Pit 84 is described as variable, and can produce select subgrade, G.B.C. A, B and C, 16 mm Crushed Stone, and H.L. 4 and 8 stone. The sand requires blending and oversize material must be removed or crushed for the production of G.B.C. B. Pit 92 contains "mainly coarse sand with small crushable area" and can produce select subgrade, G.B.C. A, B and C, 16 mm Crushed Stone B, and with blending, hot-laid sand (Deike 1978b).

Two small outwash gravel deposits located southwest of Markdale have also been selected at the secondary level of significance. The deposits contain abandoned pits 26, 27, 30, 33 and 34. The pits contain 30 to 75 percent gravel and have face heights of 5 to 20 feet (1.5 to 6 m). A sample taken from pit 26 contained 38 percent gravel, 49 percent sand and 3 percent fines (Figure 2a). The unprocessed material was suitable for use as G.B.C. B and H.L. 2, 3, 4 and 8 sand. The granular and 16 mm crushed P.N. was 106.1, well within the range for most products. A sample taken from pit 34 contained 76 percent gravel, 23 percent sand and 1 percent fines (Figure 2a). With proper processing, the material is suitable for use as granular base course and hot-laid sand.

A small area of ice-contact material located south of Markdale is also of secondary significance. Although no pits are opened in the deposit in Glenelg, a pit is located in this deposit in Artemesia Township. This pit is presently rehabilitated, but at one time was capable of producing G.B.C. A, B and C, 16 mm Crushed Stone, and H.L. 4 and 8 stone (Deike 1978a). The deposit also contains material suitable for use in hot-laid sand products with the proper blending. Oversize material must be removed or crushed for the production of G.B.C. B. The only water well in the deposit shows 117 feet (36 m) of sand and gravel.

BEDROCK GEOLOGY

Glenelg Township is underlain by the Silurian age Guelph Formation. The Guelph Formation is a tan to brown, even-textured, fine- to medium-crystalline dolostone, which appears vuggy and porous in reefal complexes (Liberty 1966). Although the dolostone has a high chemical purity and is a valuable raw material for numerous metallurgical products, it does not perform well as a load-bearing aggregate. Largely because of its unsuitability as an aggregate source and partly because of the generally thick cover of drift in the township, no bedrock areas have been selected for resource protection.

The Guelph Formation is quarried for the manufacture of dolomitic lime near Guelph and Hamilton. In the area of Glenelg Township, the

formation is very pure, generally possessing less than 1 percent impurities (Feenstra, in prep.). At the turn of the century, rock from the formation was used in many localities in Grey County for the manufacture of lime for local use. Boulders of the Guelph Formation contained in surficial materials were used where outcrops of the formation were not available (Feenstra, in prep.).

The Guelph Formation is generally soft and erodes easily. Natural processes of gravel production cause the weaker parts of the Guelph Formation to be reduced to fine aggregate, while allowing the strong durable parts of the formation to remain intact in the gravel fraction. Natural gravel derived from the Guelph Formation is therefore suitable for use as load-bearing aggregate. However, this natural selection cannot be economically duplicated when the Guelph Formation is crushed for use as aggregate. As a result, crushed stone derived from the Guelph Formation contains inherent weaknesses which make it unsuitable for use as load-bearing aggregate.

Drift thicknesses are variable in Glenelg, ranging from less than 3 feet (1 m) to at least 140 feet (43 m). The thickest drift is found in the southeastern part of the township in the Singhampton Moraine. Areas of less than 50 feet (15 m) of drift generally parallel the courses of the Saugeen and Rocky Saugeen Rivers. Bedrock outcrops also occur in these areas. A small area of less than 3 feet (1 m) of drift is located in the vicinity of the Town of Durham.

SUMMARY

The sand and gravel resources of Glenelg Township were deposited during the Great Ice Age. Five areas of outwash deposits associated with the Singhampton and Gibraltar members of the Artemesia Gravel have been selected for possible resource protection at the primary level. These resource areas contain large quantities of good-quality aggregate and are an important regional source of road-building and construction products. In addition, several deposits which form part of the Singhampton Moraine have been selected at the secondary level. These deposits are also important components of the total aggregate supply.

The township is underlain by bedrock of the Guelph Formation. The Guelph Formation is unacceptable for use as construction aggregate. As a result, no areas were selected for resource protection.

Enquiries regarding the Aggregate Resources Inventory of Glenelg Township should be directed to the Ontario Ministry of Natural Resources either at the Owen Sound District Office, 611-9th Avennue East, Owen Sound, Ontario, N4K 3E4 (Tel. (519) 376-3860) or at the Southwestern Region Geological Office, 458 Central Avenue, London, Ontario, N6B 2E5 (Tel. (519) 433-8431).

TABLE 1 | TOTAL SAND AND GRAVEL RESOURCES, GLENELG TOWNSHIP*

1 CLASS NO.	2 DEPOSIT TYPE (see Appendix C)	3 AREAL EXTENT Acres (Hectares)	4 ORIGINAL TONNAGE Millions of Tons (Tonnes)
1	G-IC	7000 (2850)	360 (325)
	G-OW	9400 (3800)	520 (470)
	S-IC	6500 (2650)	405 (365)
	S-OW	96 (39)	5 (4)
2	G-AL	40 (16)	2 (2)
	G-E	20 (8)	1 (1)
	G-OW	3100 (1260)	114 (103)
	S-E	8 (3)	<1 (<1)
	S-IC	2880 (1130)	105 (95)
	S-IC-E	112 (45)	3 (3)
	S-OW	365 (148)	14 (13)
3	G-AL	100 (40)	2 (2)
	G-IC	700 (285)	17 (15)
	G-OW	530 (214)	12 (11)
	S-AL	60 (24)	2 (2)
	S-E	230 (93)	6 (5)

TABLE 1 | TOTAL SAND AND GRAVEL RESOURCES, GLENELG TOWNSHIP*

1 CLASS NO.	2 DEPOSIT TYPE (see Appendix C)	3 AREAL EXTENT Acres (Hectares)	4 ORIGINAL TONNAGE Millions of Tons (Tonnes)
	S-IC-E	180 (73)	4 (4)
	S-IC	560 (227)	13 (12)
	S-OW	1580 (640)	32 (29)
4	G-IC	80 (32)	1 (1)
	G-OW	8 (3)	<1 (<1)
	S-IC	112 (45)	2 (2)
	S-OW	72 (29)	1 (1)
		33,500 (13 600)	1620 (1470)

* Identified deposit areas within the Town of Durham and Village of Markdale are omitted on all tables.

N.B. Minor variations in tables are caused by rounding of data.

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
LICENCED PITS							
1	MO4-099	Durham Stone and Paving Inc.	15	11	35.0 (14.2)	20-25 (6-8)	20-45
2	–	Standard Industries Ltd.	36, 37	2E	175.0 (70.8)	unopened	
3	DO6-078	Durham Stone and Paving Inc.	56	2E	51.9 (21.0)	unopened	
4	DO6-004	V. Arnett	9, 10	1N	95.0 (38.4)	15-25 (5-8)	30-70
5	DO6-005	Durham Stone and Paving Inc.	60, 61, 62	2E	300.0 (121.4)	10-20 (3-6)	40-60
6	DO6-105	Standard Industries Ltd.	17, 18	3S	100.0 (40.5)	10 (3)	15-40
7	–	Standard Industries Ltd.	21 to 26	15 to 3S & 4S	641.5 (259.6)	5-40 (1.5-12)	30-50
					1398.4 (565.9)		
UNLICENCED PITS*							
8	MO4-056	Unknown	2	3E	–	20-40 (6-12)	10-65
9	MO4-051	Unknown	3	1E	–	15 (5)	20 (overgrown)
10	MO4-053	Unknown	5	2E	–	10-15 (3-5)	70 (overgrown)
11	–	Unknown	83	2W	–	13 (4)	– (overgrown)
12	–	Unknown	6	1E	–	10-15 (3-5)	30 (partially overgrown)
13	–	Unknown	5	1E	–	5-10 (1.5-3)	20 (partially overgrown)

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
14	MO4-048	Standard Paving	6	1E	–	5-15 (1.5-5)	15-30 (partially overgrown)
15	–	Unknown	6	1E	–	5-10 (1.5-3)	20-30 (partially overgrown)
16	MO4-041	M.T.C.	7	1E	–	15-20 (5-6)	20
17	–	Unknown	7	1E	–	10-15 (3-5)	20 (partially overgrown)
18	MO4-058	Boyce	15	2E	–	15 (5)	70 (overgrown)
19	–	Unknown	18	3E	–	10-15 (3-5)	20-30
20	–	Unknown	12	3E	–	10 (3)	– (overgrown)
21	–	Unknown	11	10	–	10-15 (3-5)	30-50 (partially overgrown)
22	–	Unknown	13	10	–	5-10 (1.5-3)	30-40 (partially overgrown)
23	MO4-043	Hill	16	10	–	10-25 (3-8)	40 (partially rehabilitated)
24	–	Unknown	20	13	–	5-10 (1.5-3)	40 (overgrown)
25	–	Unknown	20	12	–	10 (3)	5-15 (overgrown)
26	–	Unknown	20	12	–	5-15 (1.5-5)	30-50 (partially overgrown)
27	–	Unknown	20	11	–	5-10 (1.5-3)	– (overgrown)
28	MO4-055	Unknown	21	10	–	10-15 (3-5)	50-60

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
29	–	Unknown	21	10	–	5-10 (1.5-3)	50-60 (overgrown)
30	MO4-098	M. Franken	23	11	–	10 (3)	50-60 (partially rehabilitated)
31	–	Unknown	23	10	–	5-10 (1.5-3)	20 (partially rehabilitated)
32	–	Unknown	24	10	–	10-15 (3-5)	30-40 (partially overgrown)
33	MO4-097	D. Arcy	24	11	–	15-20 (5-6)	30-60 (partially overgrown)
34	–	Madill	25	11	–	10-15 (3-5)	50-75
35	MO4-093	Unknown	107	2W	–	10 (3)	35 (partially overgrown)
36	–	Unknown	106	1W	–	5-10 (1.5-3)	–
37	90	McLoughry	110	1W	–	15 (5)	40-45 (partially overgrown)
38	MO4-013	Murray	22	2E	–	15 (5)	60 (overgrown)
39	MO4-055	Vaughn	21	2E	–	10 (3)	45 (overgrown)
40	–	Unknown	22	2E	–	20 (6)	–
41	MO4-061	Murray	24	2E	–	10 (3)	60 (overgrown)
42	MO4-057	Glenelg Township	25	3E	–	40 (12)	35 (overgrown)
43	–	Unknown	26	3E	–	10 (3)	25 (overgrown)

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
44	–	Unknown	27	3E	–	20-25 (6-8)	40 (rehabilitated)
45	–	Unknown	13	8	–	10-20 (3-6)	40 (partially rehabilitated)
46	–	Unknown	25	9	–	10-12 (3-4)	70 (overgrown)
47	–	Unknown	34	3E	–	20 (6)	30 (partially overgrown)
48	–	Unknown	4	7	–	10-15 (3-5)	25 (partially overgrown)
49	–	Unknown	13	6	–	20 (6)	40-50 (partially rehabilitated)
50	–	Unknown	20	7	–	5-25 (1.5-8)	30-40 (partially overgrown)
51	–	L. Eagles	28	6	–	10-15 (3-5)	30-50 (wayside)
52	DO6-067	D. Edge	19	1E	–	10-15 (3-5)	55 (partially overgrown)
53	DO6-81	Vessie	17	1E	–	10 (3)	55 (partially overgrown)
54	DO6-68	D. Edge	15	2E	–	35-40 (11-12)	30-40 (partially overgrown)
55	–	Unknown	39	3E	–	10 (3)	30 (overgrown)
56	–	Unknown	1	5	–	5-20 (1.5-6)	40 (partially overgrown)
57	–	Unknown	10	5	–	15 (5)	30 (overgrown)
58	–	Unknown	27	4	–	10 (3)	30 (rehabilitated)

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
59	–	Unknown	55	2E	–	5 (1.5)	35 (overgrown)
60	DO6-041	Ball	56	3E	–	10 (3)	20-60 (overgrown)
61	–	Muskoff	1	3N	–	15 (5)	50 (overgrown)
62	DO6-056	Farmhurst Holdings Ltd.	8	1N	–	10 (3)	40 (overgrown)
63	DO6-133	Weir	10	3N	–	10-15 (3-5)	35-60 (partially overgrown)
64	DO6-006	Unknown	3	1N	–	10 (3)	30 (partially overgrown)
65	–	Unknown	21	3N	–	5 (1.5)	40 (overgrown)
66	–	Unknown	20	2N	–	8-10 (2-3)	40 (overgrown)
67	–	Unknown	28	2N	–	5-12 (1.5-4)	10-30 (partially overgrown)
68	DO6-135	G. Seyers	39	1N	–	10 (3)	15-60 (overgrown)
69	–	Unknown	42	2N	–	5-15 (1.5-5)	35
70	DO6-138	A. Stonehouse	41	1N	–	5 (1.5)	25 (overgrown)
71	–	Unknown	54	1S	–	15 (5)	35 (overgrown)
72	DO6-002	Pratt	59	2E	–	10-15 (3-5)	25-50 (overgrown)
73	DO6-001	Bell	57	3E	–	15-20 (5-6)	40-60 (overgrown)

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
74	–	Unknown	62	3E	–	5-10 (1.5-3)	40 (partially overgrown)
75	–	Unknown	62	3E	–	5-10 (1.5-3)	40 (partially overgrown)
76	–	Unknown	20	2N	–	8-10 (2-3)	40 (overgrown)
77	–	Unknown	11	1S	–	15 (5)	30-40 (overgrown)
78	–	Unknown	11	1S	–	5 (1.5)	40 (overgrown)
79	–	Unknown	11	1S	–	10 (3)	35 (overgrown)
80	–	Unknown	11	1S	–	10 (3)	35 (overgrown)
81	–	Unknown	23	1S	–	10 (3)	35 (overgrown)
82	–	Unknown	26	1S	–	5 (1.5)	25
83	–	Unknown	30	2S	–	10 (3)	40 (partially overgrown)
84	DO6-016	McKeown	32, 33	1S	–	10-20 (3-6)	30-60 (partially overgrown)
85	–	Unknown	40	1S	–	5-15 (1.5-5)	35 (partially overgrown)
86	–	Unknown	43	2S	–	10-15 (3-5)	10-30 (partially overgrown)
87	DO6-083	Farmhurst Holdings Ltd.	29	1E	–	10 (3)	15-30 (overgrown)
88	DO6-074	Vollett	30	1E	–	10 (3)	40-65 (overgrown)

TABLE 2 | SAND AND GRAVEL PITS, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
89	DO6-110	McCraken	65	3E	–	10-15 (3-5)	20-60 (overgrown)
90	–	Unknown	1	3S	–	5 (1.5)	35 (partially overgrown)
91	–	Unknown	1	3S	–	5-10 (1.5-3)	35 (partially overgrown)
92	DO6-112	A. Lawrence	1	3S	–	10-12 (3-4)	50 (overgrown)
93	–	Unknown	70	3E	–	5 (1.5)	30-35 (partially overgrown)
94	–	Unknown	21	3S	–	10 (3)	55 (partially overgrown)
95	–	Unknown	30	3S	–	15-30 (5-9)	30-35 (partially overgrown)

* Abandoned or wayside pits operating on demand under authority of a permit.

TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, GLENELG TOWNSHIP

1 DEPOSIT NO.	2 UNLICENCED AREA Acres (Hectares)	3 CULTURAL SETBACKS Acres (Hectares)	4 EXTRACTED AREA Acres (Hectares)	5 AVAILABLE AREA Acres (Hectares)	6 ESTIMATED DEPOSIT THICKNESS Feet (Metres)	7 AVAILABLE AGGREGATE Millions of Tons (Tonnes)
1a	2190 (890)	480 (194)	20 (8)	1690 (680)	25 (8)	106 (96)
1b	3050 (1230)	980 (400)	40 (16)	2030 (820)	20 (6)	102 (92)
1c	345 (140)	110 (44)	5 (2)	230 (93)	25 (8)	14 (13)
	5600 (2270)	1570 (640)	65 (26)	3950 (1600)		222 (201)
2	580 (235)	125 (51)	15 (6)	440 (178)	20 (6)	22 (20)
3a	880 (355)	160 (65)	10 (4)	710 (285)	25 (8)	44 (40)
3b	390 (158)	70 (28)	5 (2)	315 (128)	25 (8)	20 (18)
3c	415 (168)	70 (28)	5 (2)	340 (138)	20 (6)	17 (15)
	1680 (680)	300 (121)	20 (8)	1360 (550)		81 (74)
4a	445 (180)	60 (24)	5 (2)	380 (154)	15 (5)	14 (13)
4b	205 (84)	40 (16)	0 (0)	165 (67)	15 (5)	6 (5)
4c	135 (55)	20 (8)	0 (0)	115 (46)	15 (5)	4 (4)
4d	65 (26)	20 (8)	0 (0)	45 (18)	15 (5)	2 (2)
	850 (345)	140 (57)	5 (2)	700 (285)		26 (24)

TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, GLENELG TOWNSHIP

1 DEPOSIT NO.	2 UNLICENCED AREA Acres (Hectares)	3 CULTURAL SETBACKS Acres (Hectares)	4 EXTRACTED AREA Acres (Hectares)	5 AVAILABLE AREA Acres (Hectares)	6 ESTIMATED DEPOSIT THICKNESS Feet (Metres)	7 AVAILABLE AGGREGATE Millions of Tons (Tonnes)
5a	1550 (630)	540 (218)	10 (4)	1000 (405)	15 (5)	38 (34)
5b	160 (65)	35 (14)	0 (0)	125 (51)	15 (5)	5 (4)
5c	860 (350)	140 (57)	0 (0)	720 (290)	20 (6)	36 (33)
	2550 (1030)	720 (290)	10 (4)	1840 (740)		79 (72)
	11,300 (4550)	2850 (1150)	115 (46)	8300 (3350)		430 (390)

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, GLENELG TOWNSHIP

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
0-3 (0-1)	Guelph Formation	60 (18)	35 (14)	8 (7)
3-25 (1-8)	Guelph Formation	60 (18)	6200 (2500)	1340 (1220)
25-50 (8-15)	Guelph Formation	60 (18)	9300 (3750)	2010 (1820)
			15,500 (6300)	3350 (3050)

TABLE 5 | QUARRIES, GLENELG TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)

– NONE –

TABLE 6 | SELECTED BEDROCK RESOURCE AREAS, GLENELG TOWNSHIP

1 **DEPOSIT NO.**	2 **DEPTH OF OVERBURDEN** Feet (Metres)	3 **UNLICENCED AREA** Acres (Hectares)	4 **CULTURAL SETBACKS** Acres (Hectares)	5 **EXTRACTED AREA** Acres (Hectares)	6 **AVAILABLE AREA** Acres (Hectares)	7 **ESTIMATED WORKABLE THICKNESS** Feet (Metres)	8 **AVAILABLE RESOURCES** Millions of Tons (Tonnes)

– NONE –

TABLE 7 | SUMMARY OF TEST HOLE DATA, GLENELG TOWNSHIP

Test Hole Number: GL-TH-1

Location: Lot 15, Conc. 14

Elevation: Approximately 1350 feet (411 m) a.s.l.

Date: August 13, 1981

DEPTH feet (metres)	DESCRIPTION
0-6.5 (0-2.0)	dense reddish-brown clay with angular fine gravel
6.5-16.5 (2.0-5.0)	very dense, reddish-brown clay with trace of fine gravel, fine sand and silt
	hole terminated at 16.5 feet (5.0 m)

Test Hole Number: GL-TH-2

Location: Lot 91, Conc. 1W

Elevation: Approximately 1325 feet (404 m) a.s.l.

Date: August 13, 1981

DEPTH feet (metres)	DESCRIPTION
0-6.5 (0-2.0)	coarse sand and very angular fine gravel with some silt and clay
6.5-21.5 (2.0-6.6)	medium brown clay with coarse sand and angular fine gravel
	ground water at 10 feet (3.0 m)
	hole terminated at 21.5 feet (6.6 m)

TABLE 7 | SUMMARY OF TEST HOLE DATA, GLENELG TOWNSHIP

Test Hole Number: GL-TH-3

Location: Lot 94, Conc. 3W

Elevation: Approximately 1400 feet (427 m) a.s.l.

Date: August 13, 1981

DEPTH feet (metres)	DESCRIPTION
0-11.5 (0-3.5)	compact medium brown silty clay with trace angular fine gravel.
11.5-17.5 (3.5-5.3)	dense coarse sand with some fine gravel, silt and clay
	hole terminated at 17.5 feet (5.3 m) because augers could not penetrate underlying material.

Test Hole Number: GL-TH-4

Location: Lot 13, Conc. 8

Elevation: Approximately 1325 feet (404 m) a.s.l.

Date: August 10, 1981

DEPTH feet (metres)	DESCRIPTION
0-6.5 (0-2.0)	auger meeting resistance; no sample because material too large for split spoon sampler
6.5-10 (2.0-3.0)	auger meeting resistance; grab sample taken from 6.5 to 10 feet (2.0 to 3.0 m); coarse gravel with medium sand and some silt
	hole terminated at 10 feet (3.0 m) because augers could not penetrate underlying material

TABLE 7 | SUMMARY OF TEST HOLE DATA, GLENELG TOWNSHIP

Test Hole Number: GL-TH-5

Location: Lot 18, Conc. 9

Elevation: Approximately 1375 feet (419 m) a.s.l.

Date: August 13, 1981

DEPTH feet (metres)	DESCRIPTION
0-6.5 (0-2.0)	dense light brown coarse to medium sand with some fine to coarse gravel and trace of clay
6.5-11.5 (2.0-3.5)	split spoon sampler bounced when sampling attempted (no penetration achieved); grab sample taken from 10.5 to 11.5 feet (3.2 to 3.5 m); coarse gravel with some coarse to medium sand and trace silt
11.5-21.5 (3.5-6.6)	dense coarse to fine gravel with some coarse to fine sand and trace silt
21.5-31.5 (6.6-9.6)	very dense fine sand with some silt and little to trace fine gravel to coarse sand
	hole terminated at 31.5 feet (9.6 m)

TABLE 7 | SUMMARY OF TEST HOLE DATA, GLENELG TOWNSHIP

Test Hole Number: GL-TH-6

Location: Lot 28, Conc. 8

Elevation: Approximately 1425 feet (434 m) a.s.l.

Date: August 14, 1981

DEPTH feet (metres)	DESCRIPTION
0-3 (0-0.9)	topsoil
3-6.5 (0.9-2.0)	dense wet light brown clay with trace coarse sand
6.5-11.3 (2.0-3.4)	compact wet coarse sand and fine gravel with some clay
11.3-15.5 (3.4-4.7)	compact wet light brown clay with some coarse sand and fine gravel
15.5-21.5 (4.7-6.6)	dense wet coarse to fine sand and fine gravel with some clay.
	hole terminated at 21.5 feet (6.6 m)

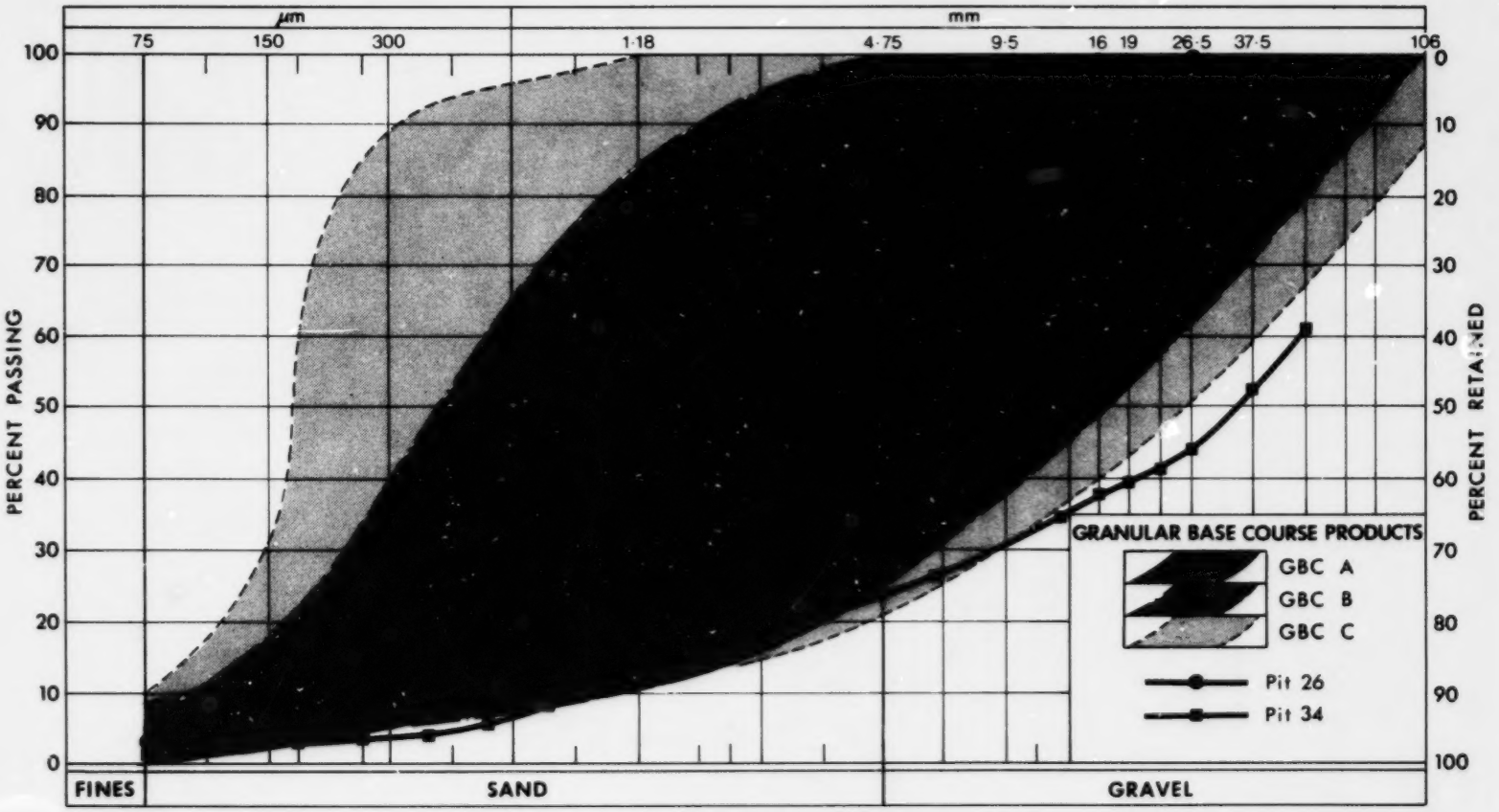


FIGURE 2a: AGGREGATE GRADING CURVES, GLENELG TOWNSHIP;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

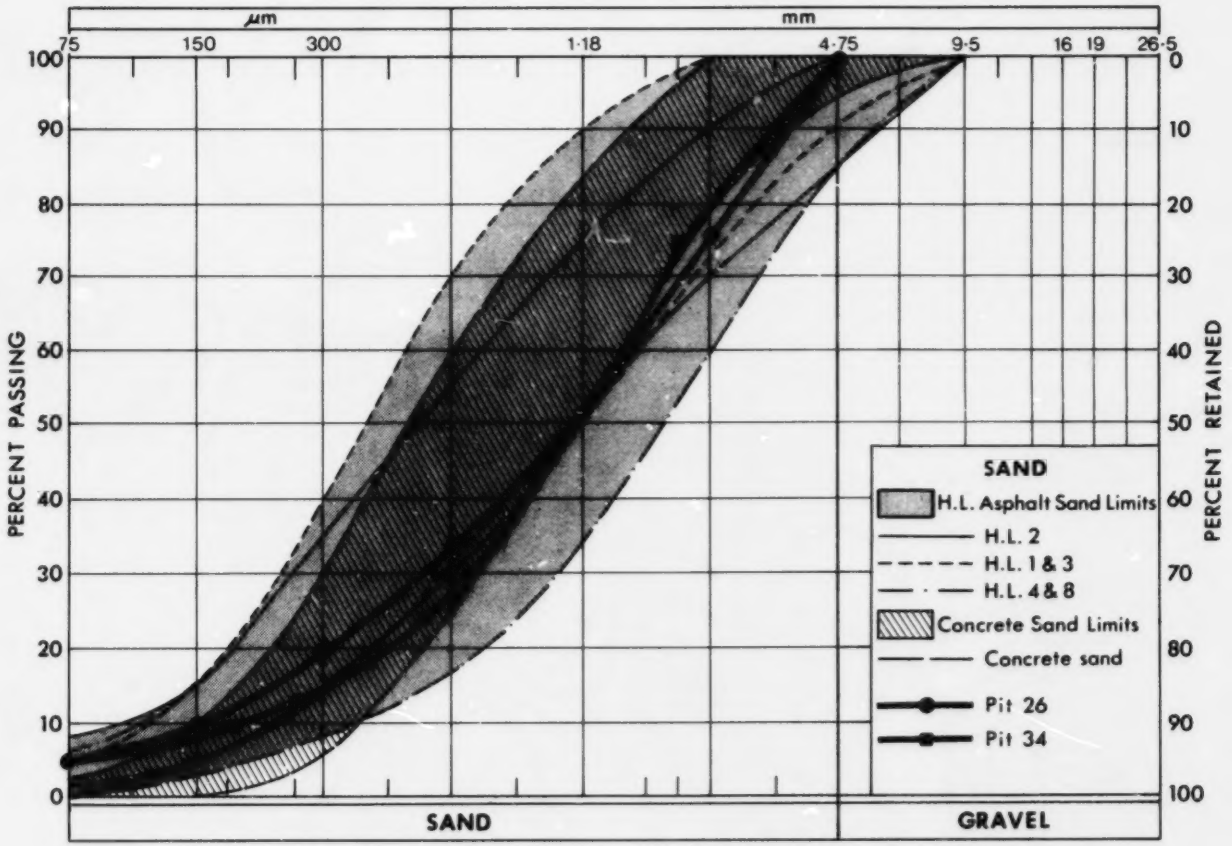


FIGURE 2b: AGGREGATE GRADING CURVES, GLENELG TOWNSHIP;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

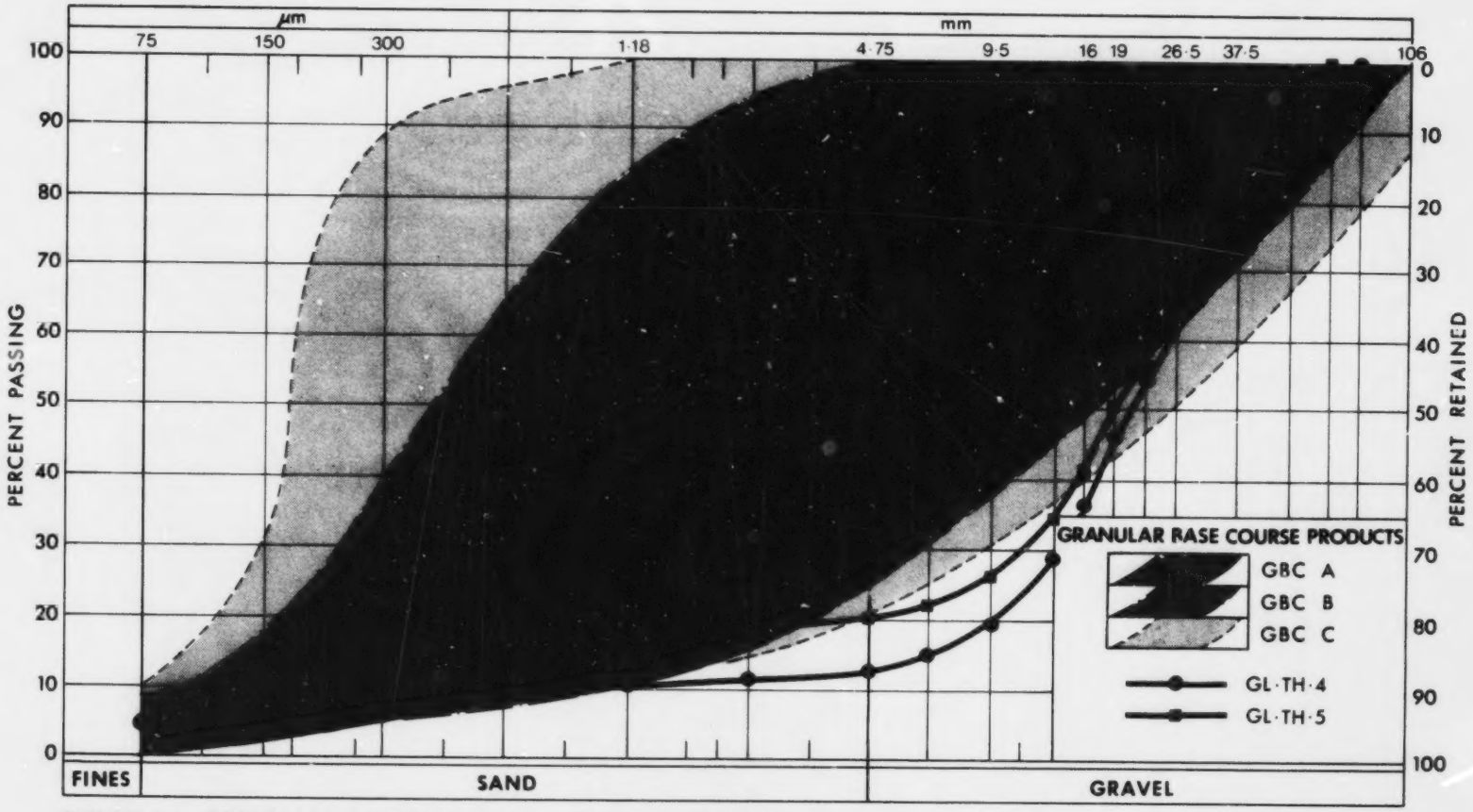


FIGURE 3a: AGGREGATE GRADING CURVES, GLENELG TOWNSHIP;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

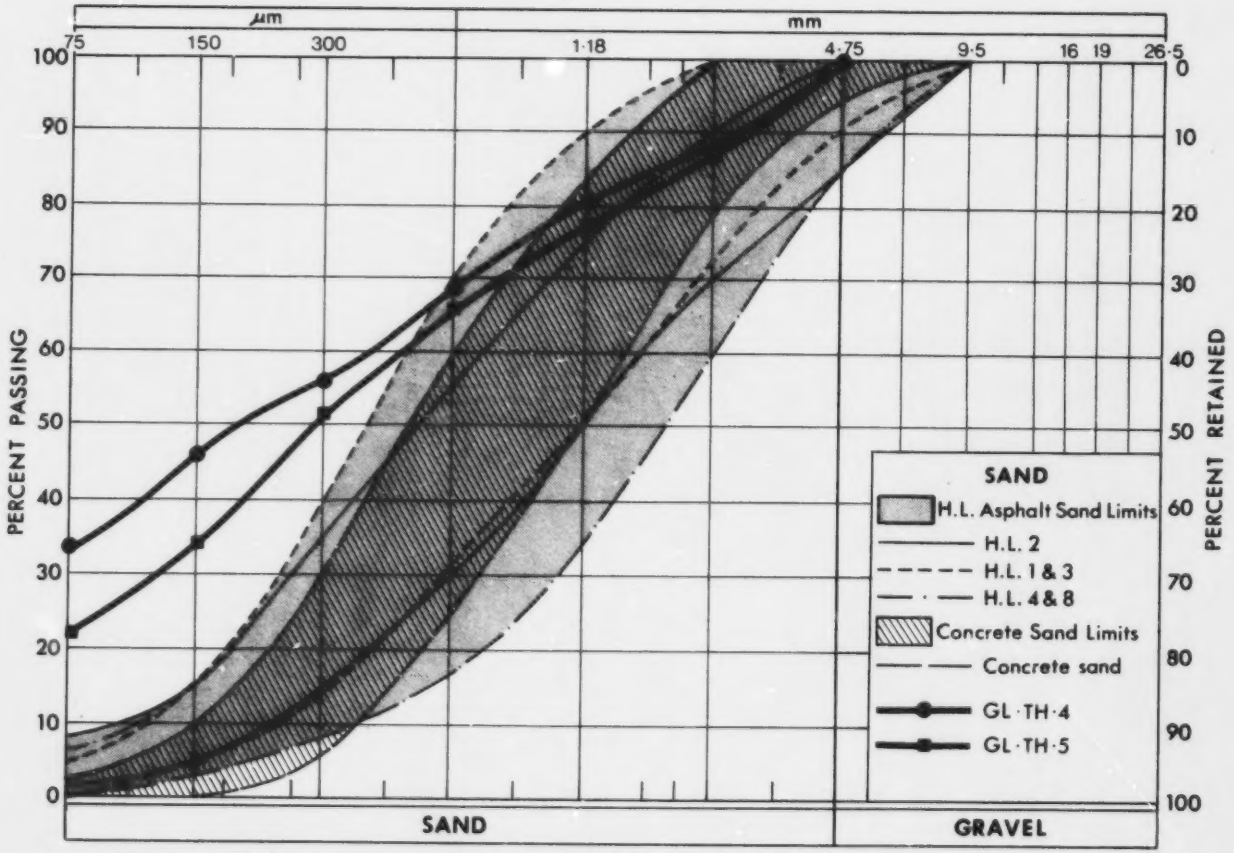


FIGURE 3b: AGGREGATE GRADING CURVES, GLENELG TOWNSHIP;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

REFERENCES

Association of Professional Engineers of Ontario
1976: Performance Standards for Professional Engineers Advising on and Reporting on Oil, Gas and Mineral Properties; Association of Professional Engineers of Ontario, 11 p.

Chapman, L.J. and Putnam, D.F.
1966: The Physiography of Southern Ontario; Second Edition, Ontario Research Foundation, University of Toronto Press, Toronto, 386 p.

Deike, W.
1978a: Aggregate Suitability Evaluation, Artemesia Township, Grey County; Aggregate Unit, Pavement Design and Management Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, 2 p., unpublished report.
1978b: Aggregate Suitability Evaluation, Glenelg Township, Grey County; Aggregate Unit, Pavement Design and Management Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, 2 p., unpublished report.

Durham Planning Board
1979: Official Plan of the Town of Durham Planning Area; 30 p.

Feenstra, B.H.
1975: Quaternary Geology of the Markdale Area (41 A/7), Grey County; pp. 116-118 in Summary of Field Work, 1975, by the Geological Branch, edited by V.G. Milne, D.F. Hewitt, K.D. Card and J.A. Robertson, Ontario Division of Mines, Miscellaneous Paper 63, 158 p.
in prep: Quaternary Geology of the Markdale Area, Southern Ontario; Ontario Geological Survey, report in preparation.

Hewitt, D.F. and Karrow, P.F.
1963: Sand and Gravel in Southern Ontario; Ontario Department of Mines, Industrial Mineral Report 11, 151 p. Accompanied by Maps 2038, 2039, 2040, 2041 and 2042, scale 1:1 013 760.

Liberty, B.A.
1966: Geology of the Bruce Peninsula, Ontario; Geological Survey of Canada, Paper 65-41, 8 p., 13 maps, scale 1:63 360.

Liberty, B.A. and Bolton, T.E.
1971: Paleozoic Geology of the Bruce Peninsula Area, Ontario; Geological Survey of Canada, Memoir 360, 163 p., 1 chart, 1 map, scale 1:253 440.

Logan, W.E.
1863: Superficial Geology; in Report on the Geology of Canada, Report of Progress to 1863, Geological Survey of Canada, pp. 886-930. Accompanying Atlas published 1865, 42 p.

Ontario
1983: The Pits and Quarries Control Act, 1971; Revised Statutes of Ontario, 1980, Chapter 378, Queen's Printer for Ontario.

Ontario Geological Survey
1981: Aggregate Resources Inventory of Artemesia Township, Grey County; Ontario Geological Survey, Aggregate Resources Inventory Paper 73, 36 p., 6 tables, 3 maps, scale 1:50 000.

Ontario Interministerial Committee on National Standards and Specifications (Metric Committee)
1975: Metric Practice Guide; 67 p.

Ontario Ministry of Municipal Affairs and Housing
1983: Municipal Directory 1983; Queen's Printer for Ontario, 241 p.

Ontario Ministry of Natural Resources
1980: Statistics 1980; Ontario Ministry of Natural Resources, 122 p.

Ontario Ministry of Treasury, Economics and Intergovernmental Affairs
1974: 1974 Municipal Directory; Queen's Printer for Ontario, 128 p.

Robertson, J.A.
1975: Mineral Deposit Studies, Mineral Potential Evaluation, and Regional Planning in Ontario; Ontario Division of Mines, Miscellaneous Paper 61, 42 p.

Sado, E.V.
1976a: Granular Aggregate Inventory of Artemesia Township, Grey County, Ontario; Ontario Division of Mines, Open File Report 5165, 17 p., 4 tables, 1 map, scale 1:50 000.
1976b: Granular Aggregate Inventory of Glenelg Township, Grey County, Ontario; Ontario Division of Mines, Open File Report 5166, 19 p., 5 tables, 1 map, scale 1:50 000.

Sharpe, D.R.
1975: Quaternary Geology of the Durham Area (41A/2), Grey County; pp. 113-115 in Summary of Field Work 1975, by the Geological Branch, Ontario Division of Mines, Miscellaneous Paper 63, 158 p.
in prep: Quaternary Geology of the Durham Area, Southern Ontario; Ontario Geological Survey, report in preparation.

Sharpe, D.R. and Broster B.E.
1977: Quaternary Geology of the Durham Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 1556, Geological Series, scale 1:50 000.
1978: Sand and Gravel Resources of the Durham Area, Grey County, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 1835, Geological Series, scale 1:50 000.

Sharpe, D.R. and Clue, J.
1978: Drift Thickness of the Durham Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 1837, Drift Thickness Series, scale 1:50 000.

APPENDIX A - SUGGESTED ADDITIONAL READING

American Geological Institute
1972: Glossary of Geology; Washington, D.C., 858 p.

Bauer, A.M.
1970: A Guide to Site Development and Rehabilitation of Pits and Quarries; Ontario Department of Mines, Industrial Mineral Report 33, 62 p.

Cowan, W.R.
1977: Toward the Inventory of Ontario's Mineral Aggregates; Ontario Geological Survey, Miscellaneous Paper 73, 19 p.

Fairbridge, R.W. (ed.)
1968: The Encyclopedia of Geomorphology; Encyclopedia of Earth Sciences, Vol. III, Reinhold Book Corp., N.Y., 1295 p.

Flint, R.F.
1971: Glacial and Quaternary Geology, John Wiley and Sons Inc., 892 p.

Hewitt, D.F.
1960: The Limestone Industries of Ontario; Ontario Department of Mines, Industrial Mineral Circular 5, 177 p.
1964a: Building Stones of Ontario, Part I Introduction; Ontario Department of Mines, Industrial Mineral Report 14, 43 p.
1964b: Building Stones of Ontario, Part II Limestone; Ontario Department of Mines, Industrial Report 15, 43 p.
1964c: Building Stones of Ontario, Part III Marble; Ontario Department of Mines, Industrial Mineral Report 16, 89 p.
1964d: Building Stones of Ontario, Part IV Sandstone; Ontario Department of Mines, Industrial Mineral Report 17, 57 p.
1972: Paleozoic Geology of Southern Ontario; Ontario Division of Mines, Geological Report 105, 18 p.

Hewitt, D.F. and Karrow, P.F.
1963: Sand and Gravel in Southern Ontario; Ontario Department of Mines, Industrial Mineral Report 11, 151 p.

Hewitt, D.F. and Vos, M.A.
1970: Urbanization and Rehabilitation of Pits and Quarries; Ontario Department of Mines, Industrial Mineral Report 34, 21 p.

Lowe, S.B.
1980: Trees and Shrubs for the Improvement and Rehabilitation of Pits and Quarries in Ontario; Ontario Ministry of Natural Resources, 71 p.

McLellan, A.G.; Yundt, S.E. and Dorfman, M.L.
1979: Abandoned Pits and Quarries in Ontario; Ontario Geological Survey, Miscellaneous Paper 79, 36 p.

Ontario Mineral Aggregate Working Party
1977: A Policy for Mineral Aggregate Resource Management in Ontario; Ontario Ministry of Natural Resources, 232 p.

Ontario Ministry of Natural Resources
1975: Vegetation for the Rehabilitation of Pits and Quarries; Forest Management Branch, Division of Forests, 38 p.

Peat, Marwick & Partners and
M.M. Dillon Limited
1981: Mineral Aggregate Transportation Study; Industrial Minerals Background Paper 1, 133 p. Summary Report 26 p.

Proctor and Redfern Limited
1974: Mineral Aggregate Study, Central Ontario Planning Region; Prepared for the Ontario Ministry of Natural Resources, over 100 p.

Proctor and Redfern Limited and
Gartner Lee Associates Limited
1975: Mineral Aggregate Study of Part of The Eastern Ontario Region; Prepared for the Ontario Ministry of Natural Resources, about 200 p.
1977: Mineral Aggregate Study and Geological Inventory, Southwestern Region of Ontario; Prepared for the Ontario Ministry of Natural Resources, about 200 p.

APPENDIX B - GLOSSARY

ABRASION RESISTANCE

Tests such as the Los Angeles Abrasion Test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

ABSORPTION CAPACITY

Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

AGGREGATE

Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

ALKALI-AGGREGATE REACTION

A chemical reaction between the alkalies of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

BLENDING

Required in cases of extreme coarseness, fineness or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

CAMBRIAN

The first period of the Paleozoic Era, thought to have covered the time between 570 and 500 million years ago; the Cambrian precedes the Ordovician Period.

CLAST

An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of a larger rock mass. Synonyms include particle and fragment.

CRUSHABLE AGGREGATE

Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

DEVONIAN

A period of the geological past thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

DOLOSTONE

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited

in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DRUMLIN

A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were deposited beneath an advancing ice sheet, and were shaped by its flow.

EOLIAN

Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

GLACIAL LOBE

A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced and retreated numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

GRADATION

The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulder	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

GRANULAR BASE COURSE

Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

HOT-LAID (OR ASPHALTIC) AGGREGATE

Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2, 6 and 8) used to bind the surface course to the underlying granular base course.

LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

MELTWATER CHANNEL

A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

ORDOVICIAN

An early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

PALEOZOIC ERA

One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

PETROGRAPHIC EXAMINATION

An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

PLEISTOCENE

An Epoch of the recent geological past including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

POSSIBLE RESOURCE

Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

SILURIAN

An early period of the Paleozoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

SOUNDNESS

The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

WISCONSINAN

Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

APPENDIX C - GEOLOGY OF SAND AND GRAVEL DEPOSITS

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

ICE-CONTACT TERRACES (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain size distribution.

KAMES (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

ESKERS (E)

Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout southern Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

UNDIFFERENTIATED ICE-CONTACT STRATIFIED DRIFT (IC)

This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

OUTWASH (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

ALLUVIUM (AL)

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and it has generally low value due to the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

GLACIOLACUSTRINE BEACH DEPOSITS (LB)

These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

GLACIOLACUSTRINE DELTAS (LD)

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

GLACIOLACUSTRINE PLAINS (LP)

The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

END MORAINES (EM)

These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

WINDBLOWN DEPOSITS (WD)

Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consist of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

APPENDIX D - GEOLOGY OF BEDROCK DEPOSITS

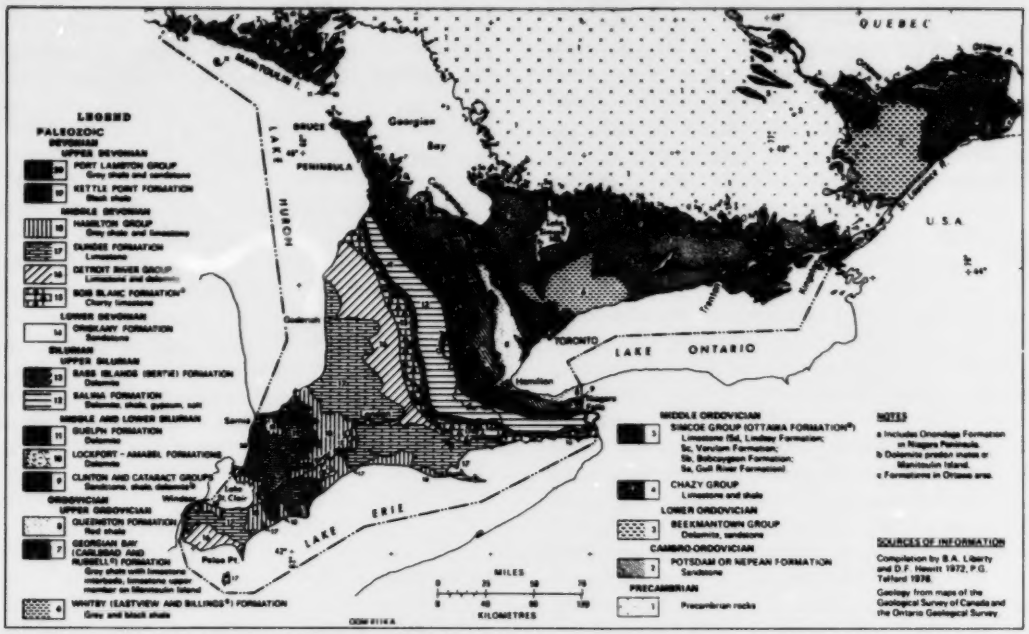


Figure 4 - Bedrock Geology of Southern Ontario

BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

BASS ISLANDS FORMATION (UPPER SILURIAN)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate due to high soundness losses.

BOBCAYGEON FORMATION (MIDDLE ORDOVICIAN)

Composition: Compact, homogeneous, medium to thin-bedded, fine-grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

BOIS BLANC FORMATION (LOWER-MIDDLE DEVONIAN)

Composition: Brownish grey, medium-crystalline, medium- to thin-bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High chert content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

DUNDEE FORMATION (MIDDLE DEVONIAN)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone.

Used at St. Marys for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

GULL RIVER FORMATION (MIDDLE ORDOVICIAN)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield, Victoria County, and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

LOCKPORT AND AMABEL FORMATIONS (MIDDLE SILURIAN)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive-bedded, fine- to medium-grained dolostone. Thickness: Amabel Formation: maximum observed thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

ONONDAGA FORMATION (MIDDLE DEVONIAN)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium-grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey brown, fine-grained, very cherty limestone having an estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High chert content makes much of the material unsuitable for concrete aggregate.

OTTAWA FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of lime for cement production and agricultural uses.

OXFORD FORMATION (LOWER ORDOVICIAN)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

DETROIT RIVER GROUP (MIDDLE DEVONIAN)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to micro-crystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces 80% of Ontario's cement. Its dolomitic reefal facies is also important for lime production to the north. It is generally unsuitable for crushed stone. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for

crushed stone.

GRENVILLE MARBLE (PRECAMBRIAN)

Composition: Recrystallized white limestone and dolostone, fine- to coarse-grained, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

GUELPH FORMATION (MIDDLE SILURIAN)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. The Guelph Formation and the underlying Amabel Formation have a combined thickness of 200 feet (61 m) on the Niagara Peninsula and more than 400 feet (122 m) on the Bruce Peninsula. Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

LINDSAY FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Member: fine-crystalline, rubbly, nodular-weathering limestone. Upper Member: grey calcareous claystone with shaly partings and bioclastic layers. The rock is "soft" and weathers to rubble. Both members are characterized by low dolomite content and by numerous clayey partings. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

VERULAM FORMATION (MIDDLE ORDOVICIAN)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for cement. The formation is unsuitable for crushed stone due to clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

GEORGIAN BAY FORMATION (UPPER ORDOVICIAN)

(Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in Metro Toronto and Cooksville produce brick and structural tile. Lightweight aggregate is also produced at Streetsville by heat expansion of the shale.

HAMILTON GROUP (MIDDLE DEVONIAN)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile and brick.

QUEENSTON FORMATION (UPPER ORDOVICIAN)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

NEPEAN (POTSDAM) FORMATION (CAMBRO-ORDOVICIAN)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

SALINA FORMATION (UPPER SILURIAN)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum.

The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

WHITBY FORMATION (UPPER ORDOVICIAN)

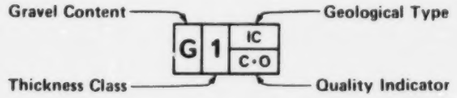
(Formerly known as Collingwood Shale near Toronto) Composition: Brown to black fissile shale. Uses: Quarried at Bowmanville for use in cement production. Testing indicates that the Whitby Formation may produce satisfactory lightweight expanded aggregate.

LEGEND
(Continued from right margin)

TEXTURE SYMBOL

The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

DEPOSIT SYMBOL



Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in Feet (Metres)	Tons per Acre	Tonnes per Hectare
1	greater than 20 (>6)	greater than 50,000	greater than 112 000
2	10 - 20 (3 - 6)	25,000 - 50,000	56 000 - 112 000
3	5 - 10 (1.5 - 3)	12,500 - 25,000	28 000 - 56 000
4	less than 5 (<1.5)	less than 12,500	less than 28 000

Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	**LP**	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	**WD**	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

	If blank, no known limitations present.
C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

SOURCES OF INFORMATION

This map by Surveys and Mapping Branch, Ontario Ministry of Natural Re-

Ministry of Natural Resources

Ontario

Hon. Alan W. Pope
Minister

J. R. Sloan
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

GLENELG TOWNSHIP

GREY COUNTY

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/2, 41 A/7

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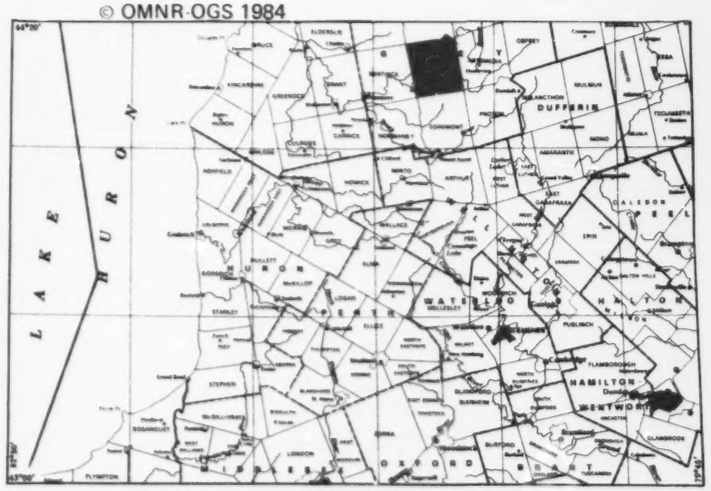

LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

- Gravel deposit.
- Sand deposit.
- Gravel overlain by other surficial material.

GREY CO
HOLLAND TP
GLENELG TP
Glascott
Dornoch
Bells Lake
Townsend Lake
Laurston
Markdale
Gravel Pit
Curling
Motel
Transformer Sta
Dugout
Wandby
Creek
Black
Travers
Irish Lake
McCormick Lake
BENTINCK TP
ARTEMESIA TP
3a
3b
3c
4b
4c
4d
1a
1b
2

Ministry of Natural Resources

Ontario

Hon. Alan W. Pope
Minister

J. R. Sloan
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

GLENELG TOWNSHIP

GREY COUNTY

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/2, 41 A/7

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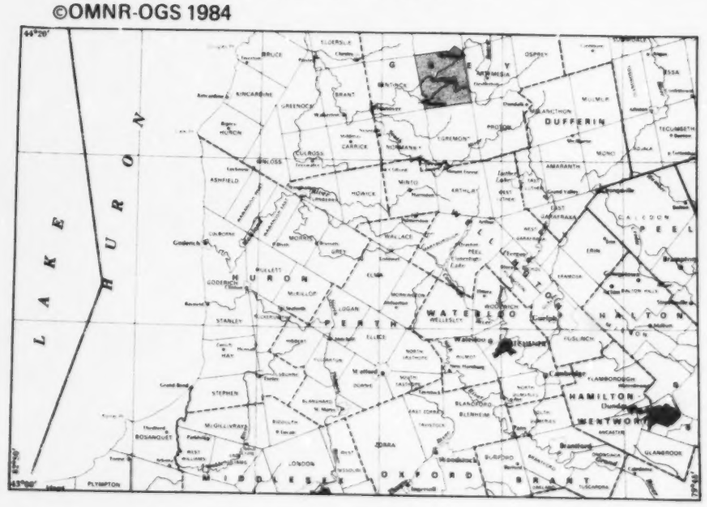

LEGEND

MAP UNITS

Selected sand and gravel resource area, primary significance; deposit number; see Table 3.

Selected sand and gravel resource area, secondary significance.

Selected sand and gravel resource area, tertiary significance.

SYMBOLS

LEGEND

(Continued from right margin)

SYMBOLS

(1)	Selected bedrock resource area; deposit number; see Table 6.
	Geological formation boundary.
	Geological formation member boundary.
	Formation thickness boundary (see text).
25	Drift thickness contour. (3-foot, 25-foot and 50-foot contours are shown).
	Municipal boundary.
Q2	Licenced quarry boundary; Property number: see Table 5.
Q3	Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.
x	Isolated bedrock outcrop.
24	Selected water well location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B. A. Liberty, 1966.
B. A. Liberty and T. E. Bolton, 1971.
D. R. Sharpe and J. Clue, 1978.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 83.

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Issued 1984.

Ministry of Natural Resources

Hon. Alan W. Pope
Minister

J. R. Sloan
Deputy Minister

Ontario

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

GLENELG TOWNSHIP

GREY COUNTY

MAP 3
BEDROCK RESOURCES

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/2, 41 A/7

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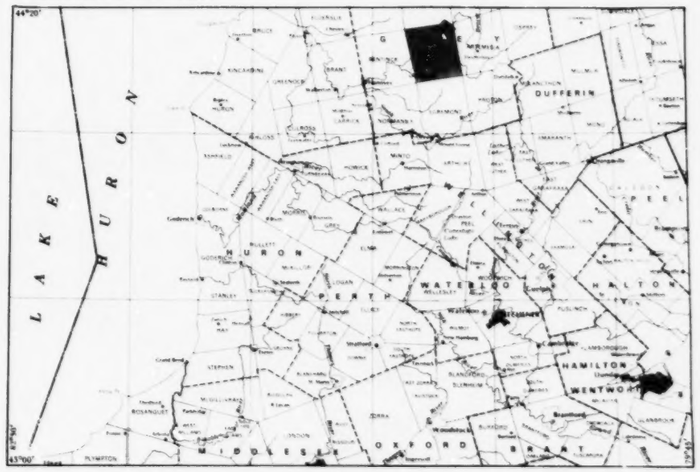

LEGEND

(Some units and symbols may not apply to this map.)

BEDROCK UNITS

PALEOZOIC

SILURIAN

MIDDLE SILURIAN

GUELPH FORMATION

Dolostone

DRIFT THICKNESS

4	less than 5 (<1.5)	less than 12,500	less than 28 000

Geological Type

AL	Older Alluvium	K	Kame
E	Esker	LB	Lacustrine Beach
EM	End Moraine	LD	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	LP	Lacustrine Plain
ICT	Ice-Contact Terrace	OW	Outwash
		WD	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

If blank, no known limitations present.

C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources.

Selected water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B. H. Feenstra, in prep.

D. R. Sharpe, in prep.

D. R. Sharpe and B. E. Broster, 1977, 1978.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

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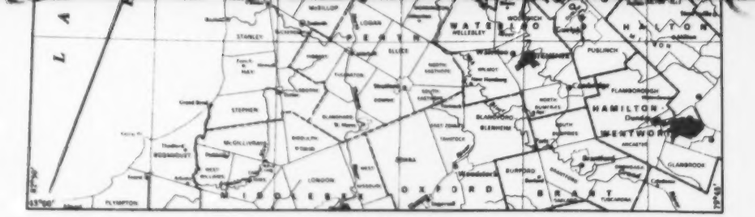
Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.



LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

- Gravel deposit.
- Sand deposit.
- Gravel overlain by other surficial material.
- Sand overlain by other surficial material.
- Other surficial deposits or exposed bedrock.

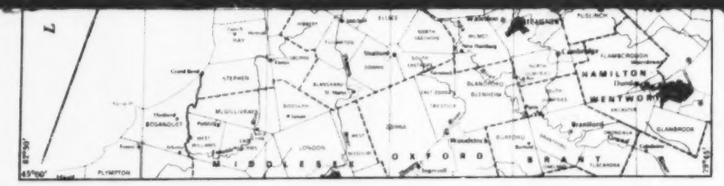
SYMBOLS

- Geological and aggregate thickness boundary of sand and gravel deposits.
- Municipal boundary.
- 2 — Licenced property boundary; Property number: see Table 2.
- 3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
  *Abandoned pit or wayside pit operating on demand under authority of a permit.
- GL-TH-2 — Test hole location; identification number; see Table 7.
- 6 / 24G — Selected water well location. Layers of materials are described by: reported thickness of material (in feet); reported type of material (number only - overburden, G- gravel, S - sand, C - clay, T - till, B - boulders, Bk - bedrock, stn - stones).
- G 1 IC C-O — Deposit symbol; see left margin.
- Texture symbol; see left margin; see Figures 2 & 3.
- GL-GT-2 — Geophysical traverse line; Identification number.

(Continued at left margin)

GLENELG

GLENELG



LEGEND

MAP UNITS

1 — Selected sand and gravel resource area, primary significance; deposit number; see Table 3.

Selected sand and gravel resource area, secondary significance.

Selected sand and gravel resource area, tertiary significance.

SYMBOLS

Geological and aggregate thickness boundary of sand and gravel deposits.

Municipal boundary

2 — Licenced property boundary; Property number: see Table 2.

3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
*Abandoned pit or wayside pit operating on demand under authority of a permit.

SOURCES OF INFORMATION

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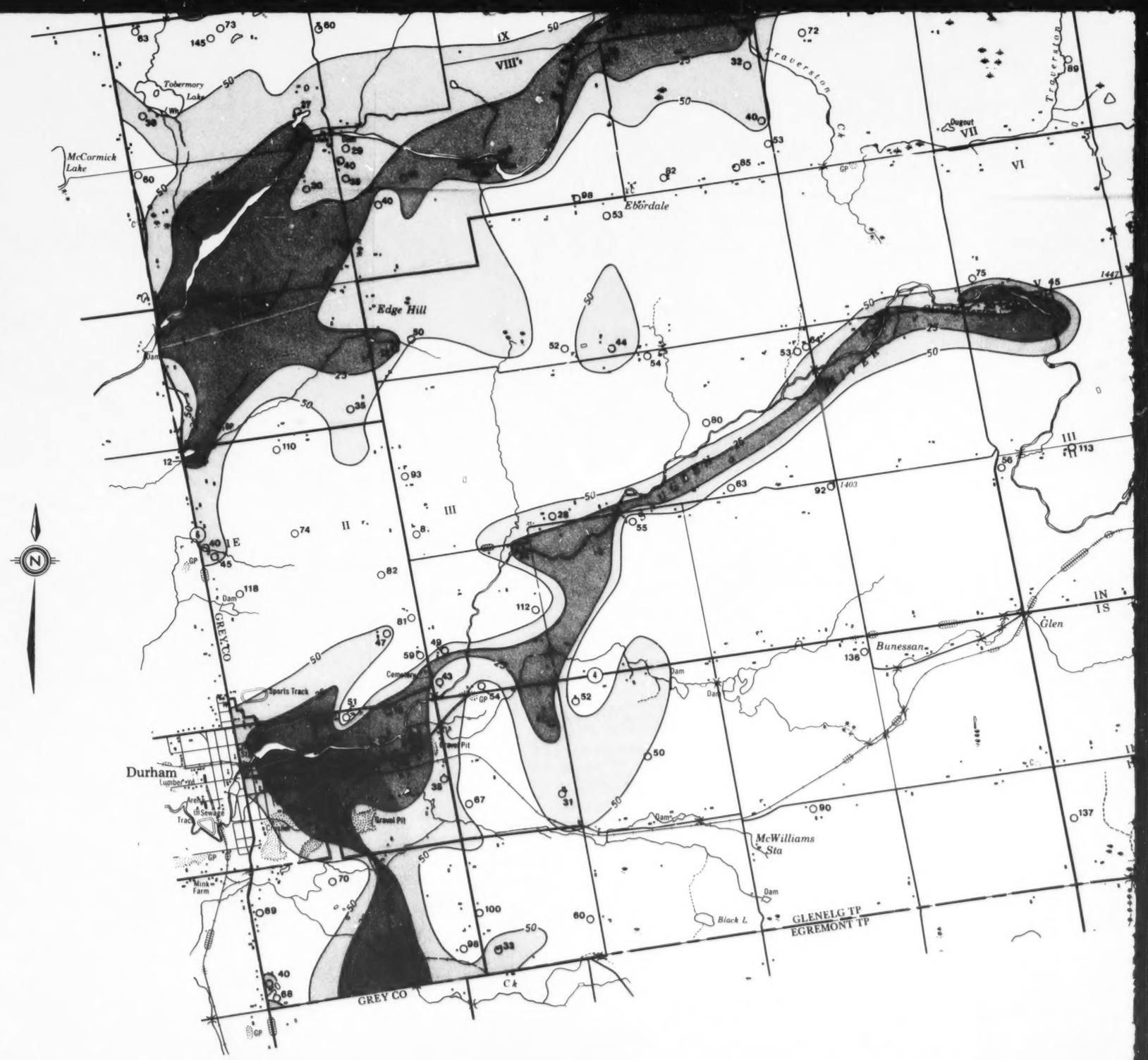

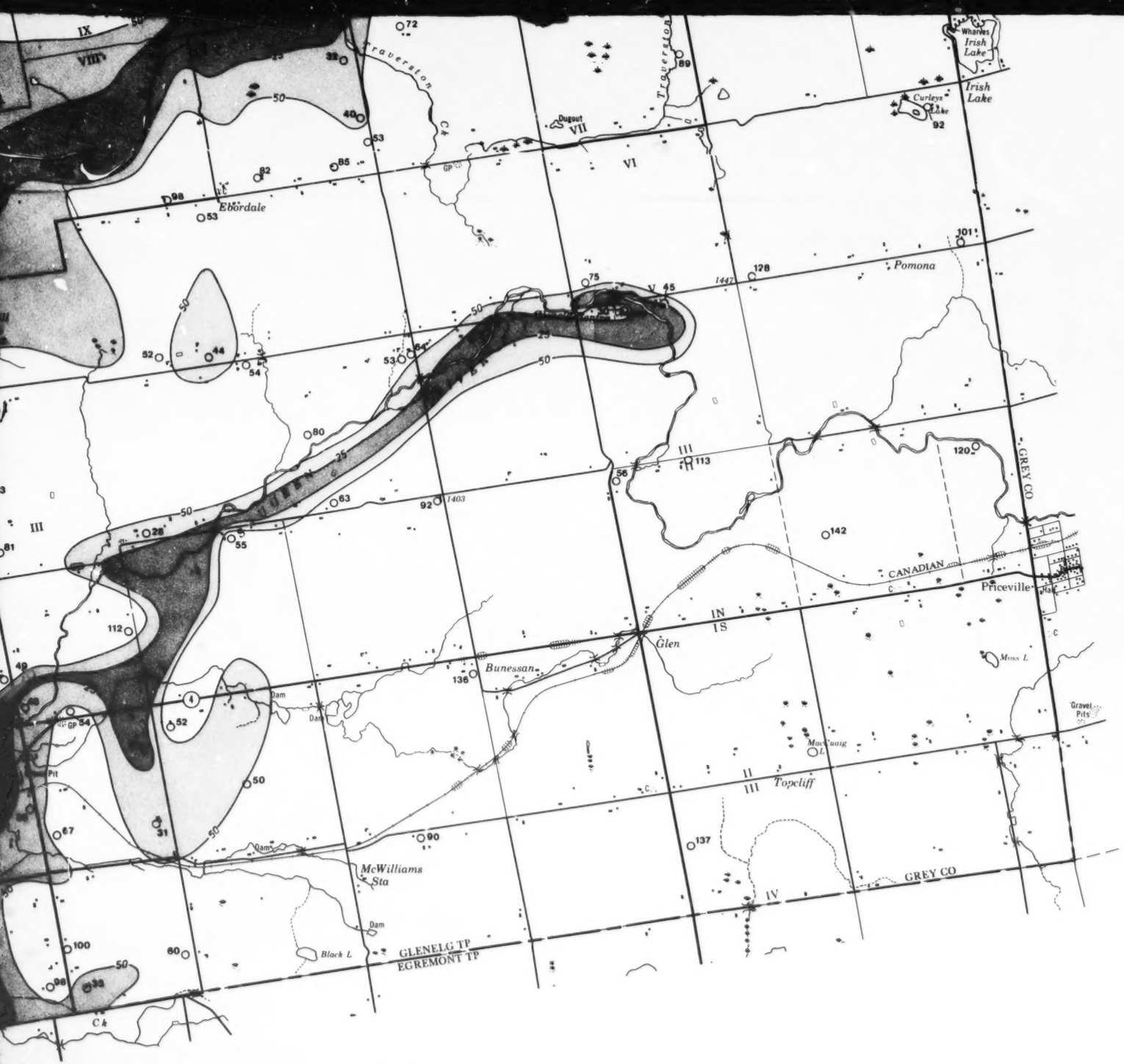

LEGEND

(Some units and symbols may not apply to this map.)

BEDROCK UNITS

PALEOZOIC

SILURIAN

MIDDLE SILURIAN

GUELPH FORMATION

Dolostone

DRIFT THICKNESS

Bedrock outcrop (see Table 4); areas of exposed bedrock partially covered by a thin veneer of drift. Drift thickness is generally less than 3 feet (1 m).

Bedrock covered by drift (see Table 4); drift thickness is generally 3 to 25 feet (1 to 8 m). Bedrock outcrops may occur.

Bedrock covered by drift (see Table 4); drift thickness is generally 25 to 50 feet (8 to 15 m). Isolated bedrock outcrops may occur.

Bedrock covered by drift; drift thickness is generally greater than 50 feet (15 m).

(Continued at left margin)